NS-7

ıred for: George C. Marshall Space Flig
NASA, Huntsville, Alabama
Contract No. NAS8-11579

GULTON INDUSTRIES

212 Durham Ave.
Metuchen, New Jersey

FINAL REPORT

DESIGN DEVELOPMENT, FABRICATION AND DELIVERY OF ONE SOUND INTENSITY CALIBRATOR

Prepared for: George C. Marshall Space Flight Center
NASA, Huntsville, Alabama
Contract No. NAS8-11579

Prepared by: Albert Gillen
Albert Gillen
Electronics Engineer
Instrumentation Division
Gulton Industries, Inc.
Metuchen, New Jersey

Date: May 3, 1965

Approved by: A. W. Orlacchio
A. W. Orlacchio
Asst. General Manager
Instrumentation Division

M. A. Lowy
General Manager
Instrumentation Division

TABLE OF CONTENTS

TABLE OF FIGURES

GULTON INDUSTRIES, INC.
Metuchen, N. J.

FINAL REPORT

DESIGN DEVELOPMENT, FABRICATION AND DELIVERY OF ONE SOUND INTENSITY CALIBRATOR

1. INTRODUCTION

In recent years booster rockets have been developed with consistently higher thrusts. An unwanted by product of the immense power is the airborne sound energy. Measurements of this energy are required to check out design performance and to set design criteria for equipment which must operate in the environment. Microphones have been designed for the specific measurement of these levels with full scale ranges sometimes in excess of 190 decibels re: .0002 dynes per square centimeter. The problem is however, that these microphones should be accurately calibrated over their entire range. In air this is a difficult process owing to the inherent non-linearity associated with the high sound pressure levels.

The sound intensity calibrator developed under contract NAS8-11579 fills this need and provides for calibrations of microphones at sound levels up to 190 decibels.

The technical approach was unique in that a liquid coupler was utilized instead of air. This approach resulted in a calibrator which fully satisfied the contract performance requirements.

It is worthwhile to point out that the contract was of the cost-plus-incentive-fee type where the cost, delivery, and specifications were incentivized. It is believed that this incentive contract has resulted in a product having greater versatility at less cost to the Government.

2. TECHNICAL REQUIREMENTS

The following specifications listed below are taken from contract No. NAS8-11579. They indicate both the target specifications as well as the most optimistic performance incentives.

2.1 The sound intensity range shall be from 110 decibels to 175 decibels (re: 0.0002 dyne/cm^2) (Most optimum performance 190db).

2.2 The sound intensity calibrator shall have the following characteristics:

(a) Sound pressure level ref. .0002 dyne/cm^2 in one decibel steps from 110 decibels to 175 decibels ±1% (most optimum performance 190db).

(b) Frequency response 16 cycles to 10KC with the following frequencies available: 16, 20,25, 31.5, 40, 50, 63, 80, 125, 160, 200, 250, 315, 400, 500, 630, 800, 1000, 1250, 1600, 2000, 2500, 3150, 4000, 6300, 8000, 10,000 ±0.5 cycle (most optimum performance 6 cps).

(c) There shall be a calibration system incorporated in the sound intensity calibrator to calibrate the calibrated standard. It shall have four frequencies (100, 400, 1KC, 6KC) available. It shall also have three different (120 decibels, 140 decibels, 160 decibels) sound pressure levels. This calibration system shall be ±0.25% accurate in reference to the National Bureau of Standards.

An installation of a calibrated standard (±0.5% in reference to National Bureau of Standards) to serve as a reference will be incorporated in the system.

(d) A method of inserting a "Gulton P420M-6" Microphone into the sound intensity calibrator for calibration shall be provided. The SPL on this microphone shall be the same SPL as on the reference microphone throughout the SPL range. The waveform shall be sinusoidal output at the above frequencies.

(e) The SPL shall not exceed 110 decibels ref .0002 dynes/cm^2 from the exterior of the sound intensity calibrator when the SPL in the interior of the sound intensity calibrator is 175 decibels (ref. .0002 dyne/cm^2).

(f) The physical size of the system shall not be larger than 3' x 3' x 4' and shall be portable.

(g) The system shall operate off of 110 volts ±3 volts and a frequency of 60 cycles ±2 cycles.

Delivery

Target delivery 10 months from origination. The most optimistic delivery (7 months).

3. TECHNICAL APPROACH

The basic approach is to use a small liquid filled chamber driven at one end by means of a piston. Motion of the sealed piston tends to compress the liquid producing relatively high pressures for small excursions of the piston. In actuality the piston is a stack of piezoelectric plates which are electrically excited. One can calculate the necessary displacement of the piston to produce a sound level of 190db in the following way:

The isothermal compressibility of water or any other liquid is expressed as:

$$\chi_T = \frac{C}{L_T + P}$$

where C = 0.1368, a constant independent of temperature

L_T = a factor dependent on temperature

P = absolute pressure

For water χ_T = *4.56 x 10^{-11} $\frac{cm^2}{dyne}$ = 3.14 x 10^{-6} $\frac{inches^2}{lb.}$

*See Handbook of Chemistry and Physics

Dimensionally $\chi_T = \frac{cm^2}{dyne} = \frac{cm^3/cm^3}{dyne/cm^2}$

where

ΔV = volume change

V = original volume

P = applied pressure

ΔL = piston stroke

A_1 = piston area

A_2 = chamber equivalent area

L = chamber equivalent length

The desired sound level is 190 decibels. This corresponds to the following pressure level:

$$db = 20 \log \frac{P}{Pref.}$$

P = actual pressure

Pref. = reference pressure (.0002 $dynes/cm^2$)

$$P_1 = Pref \ \ \underline{antilog \ db} \\ 20$$

$$= .0002 \times \text{antilog } 9.5$$

$$= 6.32 \times 10^5 \ dynes/cm^2 = 9.24 \ lbs/square \ inch$$

The drive piston in the final design (see Figure 1) has an effective diameter of 1.5 inches which corresponds to an area of 1.77 square inches.

The shape of the cavity (chamber) is in effect a rectangle intercepting a comic frustrum having an overall volume of approximately 1.2 cubic inches that is to say that $V = 1.2 = A_2 L$.

The driver stack (piston) consists of a number of thin discs of piezoelectric ceramic cemented together with an epoxy cement to form a cylindrical column. A voltage applied across the faces of each disc, all of which are connected electrically in parallel causes each to expand and/or contract depending upon the form of the impressed voltage. The piezoelectric coefficient defining this motion in the d_{33} coefficient and is expressed in meters per volt:

$$\text{the } d_{33} = \frac{\text{meters}}{\text{volt}} = \frac{\dfrac{\text{change of length}}{\text{original length of stack}}}{\text{applied field}} = \frac{\dfrac{\Delta L}{L_S}}{E}$$

For the particular material used

$$d_{33} = 200 \times 10^{-12} \text{ meters/volt} - 78.8 \times 10^{-10} \text{ inches/volt}$$

$$E = \frac{\dfrac{\Delta L}{L_S}}{78.8 \times 10^{-10}}$$

Combining the equations and solving for the required drive voltage "E":

$$E = \frac{PA_2L\ X_T}{d_{33}A_1L_s} = 3.98 \times 10^{-2}\ \frac{PA_2L}{A_1L_s}$$

For the design selected

A_2L_2 = 1.20 cubic inches

A_1 = 1.77 square inches

L_s = 1.2 inches

P = 9.24 lbs/square inch

$$E = \frac{9.24 \times 1.2 \quad 3.98 \times 10^2}{1.77 \times 1.2} = 2080 \text{ volts}$$

In the present design twelve individual piezoelectric plates are used in parallel thus lowering the required drive level from 2080 to $\frac{2080}{12}$ or 173 volts.

Actual experiment with the final chamber shows that 300 volts (rms) are needed to obtain 190db of sound level. This apparently large difference between the calculated value and the experimental value is most likely due to the volume compliance of the chamber and components affixed to the chamber, i.e., pressure gage, microphones, gaskets, seals, etc.

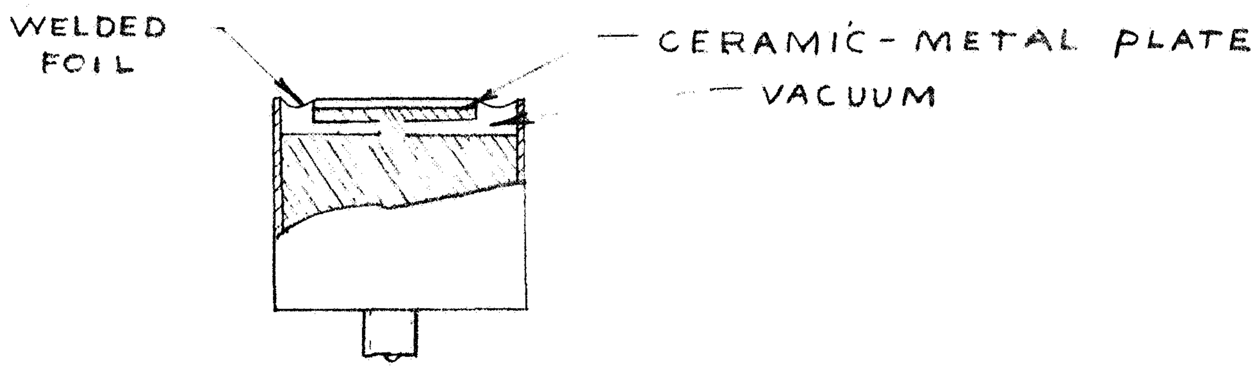
4. EXPLANATION OF THE CALIBRATOR DESIGN

Figure 2 shows the assembly drawing of the high intensity calibrator. This drawing shows the swivel stand, adjustment valves, microphones and pressure gage. A sub-assembly drawing of the calibrator is shown in Figure 3. A cutaway section shows the internal construction of the driver stack (piston), the chamber proper with the microphones located in their calibration positions. The needle valves, item 16, are shown in a cutaway view. Two such valves are used in the design. One is used to isolate the chamber from the external fill. The other is used to isolate the pressure sensor from the main chamber. The chamber operates in the following manner: Electrical excitation of the piezoelectric driver item 4, through connector 5 causes the driver stack to expand and contract. Motion of the piston against the diaphragm causes a change in the chamber volume. With needle valve 16 in the closed position, no liquid can escape from the chamber and the pressure varies proportionally to the displacement of the piston.

The needle valves play an important role in the operation of the chamber. Ostentatiously, they isolate the flow of liquid to and from the chamber and also to and from the pressure gage. In addition,to that function they have built in safety adjustment which protect the microphones. In the early stages of the development program simple shut-off valves were used in place of the modified needle valves. It was found that evacuation of the air bubbles from the chamber caused cooling of the chamber. When the valves were left in the closed position pressure would devel op within the chamber causing severe damage to the transducers. This problem area was circumvented by developing a dual purpose needle valve. Basically a fine needle valve was constructed within the main needle. This allowed a controlled flow past the valve even when the main valve was in the closed position. The fine needle is adjusted to produce a flow low enough as not to affect the operation of the chamber even at the low frequency of operation (6 cps).

Since the dimensions of the chamber are small in relation to the wavelength of sound in the medium pressures, all points within the chamber are the same. Thus, equipressure is applied to both the microphone and pressure gage. The pressure sensor is used as the transfer standard of the system. This gage is calibrated statically by means of a precision mercury monometer or other type of precise calibration techniques. The particular gage used is of the strain gage type having a seismic resonance greater than 2KC. Calculations based upon a single degree-of-freedom system show that a system of this type is flat from dc to at least 200 cps. Above this frequency range at 200 cps the pressure level is transferred to the standard microphone which is then used as the standard out to 10KC. The relative response of this transducer is checked free field out to 10KC and these values are used as the reference level. Calibration of a test transducer is accomplished then by a comparison technique first with the pressure gage to 200 cps then against the standard microphone out to 10KC.

It must be pointed out that while the liquid coupler is advantageous in obtaining the necessary sound intensity level it does exhibit one problem area. The problem arises due to the fact that some of the liquid coupling media tends to move with the transducer sensing face. The result of this is to essentially add mass to the assembly thus lowering its resonance. Calculations made on the Gulton P420M-6 microphone indicate that the resonance lowering of the seismic resonance is small being on the order of 10%; however, if one looks carefully at the construction of the device there is one other possible resonance that is of importance. The sketch below shows basically the typical microphone construction.



The problem area with this device is the unsupported area between the ceramic-metal plate and the outside edge of the microphone. Mass lowering of this resonance causes the minor resonance to fall within the usable range of the unit, i.e., 6KC to 7KC. The internal standard microphone was constructed using foil .001 inch thick. This is four times the thickness of production type units and resulted in resonances above 10KC. Operation of the device out to 5KC even with units having .00025 inch thick diaphragms was found to be satisfactory.

5. SUPPORT EQUIPMENT DESCRIPTION

A picture of the system and outline drawings are shown in Figures 4, 5 and 6. The system is split into two separate sections. The portable stand contains the calibrator chamber, the evacuation pump and a pressure supply system. The console assembly contains the electrical driver and the readout assembly. The driver consists of a beat frequency oscillator, a power amplifier, an impedance matching inductor and a precision decade attenuator (used for fine amplitude control). The readout assembly includes a dual channel cathode follower decade amplifier, analog-to-digital convertors and two digital voltmeters. A patch panel is included to increase the versatility of the equipment. It enables external connection to the auxiliary devices and allows an interchange of electrical inputs.

6. SYSTEM OPERATION

A simplified block diagram is shown in Figure 7. The calibration chamber is evacuated and filled by means of the vacuum pump and air supply system. The evacuation system is used to remove all air pockets from the chamber. Presence of small air bubbles cause a decrease in the attainable sound level within the system. The air supply is derived from a pressurized air tank with a 2000 psi source pressure. Two successive pressure regulators reduce this pressure to four (4) psi. It has been found that this low static pressure is necessary to collapse any remaining entrapped air and to provide a bias above atmosphere. The pressure level is not critical and no attempt was made to regulate this level better than $\pm 10\%$.

Once the chamber has been completely filled with liquid and the reservoir needle valve has been closed (except for the leakage noted in the section of chamber design) the system is ready to operate.

Frequency selection is made at the oscillator. Control of this output can be made either by means of a decade attenuator or a high resolution potentiometer. Output of the oscillator is amplified by the power amplifier to excite the ceramic driver. A tuning inductor is incorporated to match the impedance of the amplifier to ceramic driver. Excitation of the driver causes a sound level to be produced within the chamber. This sound pressure is sensed by the transducers within the chamber. Three separate readouts are present for measurement of sensor voltage. These readouts include amplifiers A/D converters, digital display and meter readout.

In addition to the manual operation described above the system has an automatic mode where a complete frequency response in a test microphone can be produced. When operating in this mode the secondary standard microphone acts as the control sensor for the system. After amplification the output of the standard feeds back to the oscillator which then adjusts the drive level to maintain constant sound intensity within the chamber.

A motor drive control sweeps the frequency automatically over any desired portion of the system response (6 cps to 10K cps).

6. PERFORMANCE DATA

The accuracy of performance of the high intensity calibrator system is largely dependent upon the calibration of the pressure gage. This unit is calibrated at the factory using a dead weight type tester. The range of the instrument is -2.5 psid to +25 psid with an overall accuracy of 0.75% or less than 0.1db error. The output voltage of the pressure gage with amplifier is adjusted to provide 5V DC for 25 psi or $\frac{1V\ DC}{5\ psi\ DC}$ or $\frac{1V\ (rms)}{5\ psi\ (rms)}$

The sound level within the chamber is set by means of the pressure gage. Converting this pressure level to an equivalent db value result in the following for a pressure level of 5 psi (rms).

$$db = 20 \log \frac{P}{Pref.} \quad , \; P = 5 \text{ psi} = \frac{5}{1.45 \times 10^{-5}} \quad dyne/cm^2$$

$$Pref = .0002 \text{ dynes/cm}^2$$

$$db = 20 \log \frac{3.45 \times 10^{-5}}{2 \times 10^{-4}}$$

$$= 184.74db$$

The internal standard microphone, Gulton Model MA299561, is used as the standard in the frequency range of 200 cps to 10,000 cps. This gage derives its level from the transfer level of the pressure gage. The main requirement of this device is to have a good frequency response in the above range. In order to verify the response the microphone was calibrated at Western Electro-Acoustical Laboratories (WEAL) over a frequency range of 20 cps to 10,000 cps at parallel and perpendicular incidence. Response of this unit in a liquid media will approach the response indicated by the parallel incidence plot owing to the long wavelength of sound within the coupling liquid. Figure 8 shows a typical response of the transducer between 20 cps and 1000 cps. Using the WEAL calibrated unit as the system standard (above 200 cps) a response of a second microphone was recorded to determine if any chamber resonances exists. Results of this test are shown in Figure 9. Essentially, this run indicates tracking between the test unit and the calibrated standard.

Utilizing the pressure gage as the reference measurement and the standard microphone as the level indicator, a run was performed to determine that maximum sound intensity that was attainable. In this calibration run no attempt was made to drive above 190db although over portions of the range levels above that figure are possible. Essentially 190db can be produced from 6 cps through 6KC. Figure 10 shows the results of this run.

7. SUMMARY

The development effort of contract NAS8-11579 resulted in a calibration system which met all of the technical performance requirements and in many areas including sound intensity level and frequency response reached the "most optimum" performance levels.

AG:ams
5/3/65

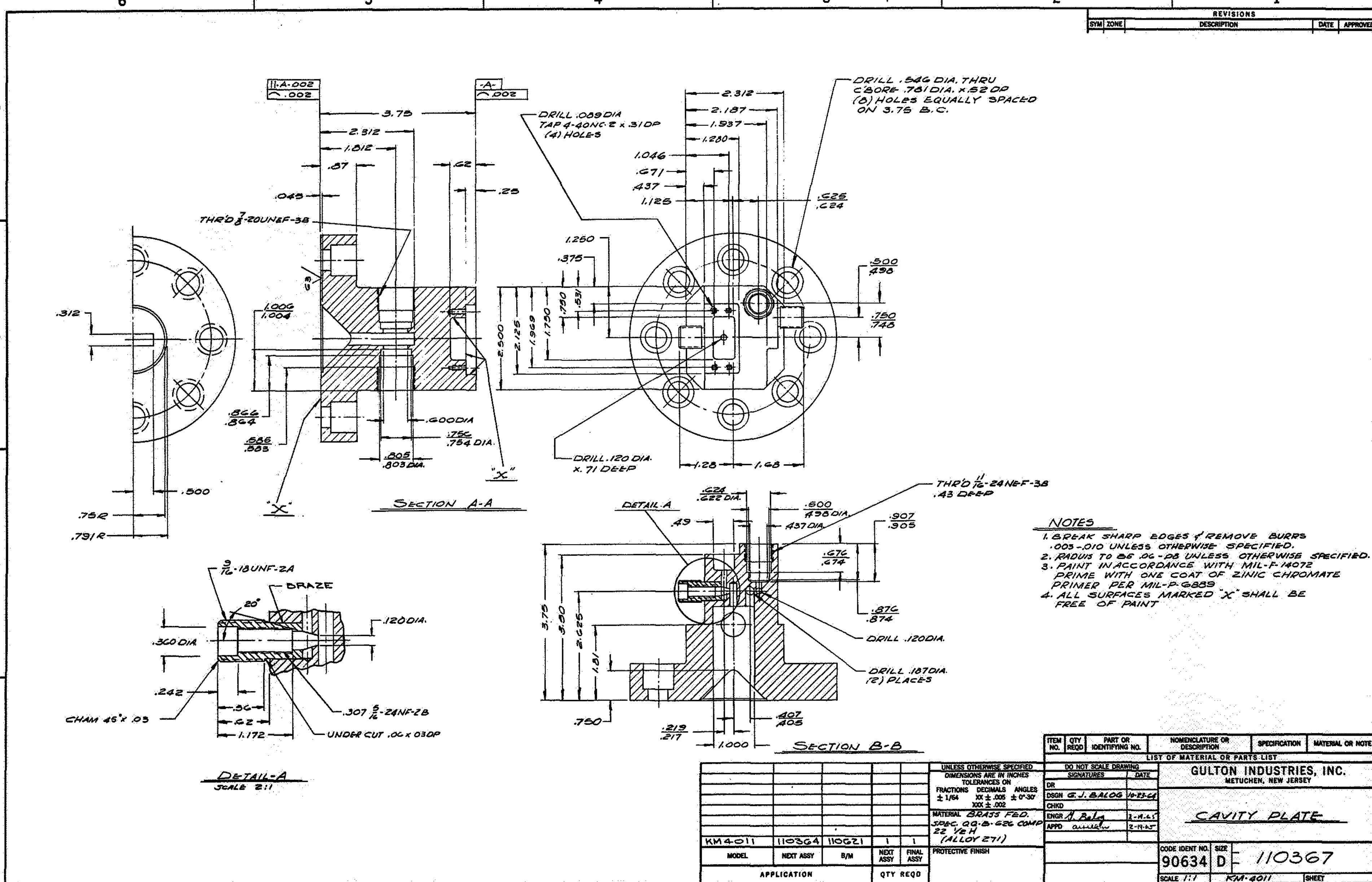
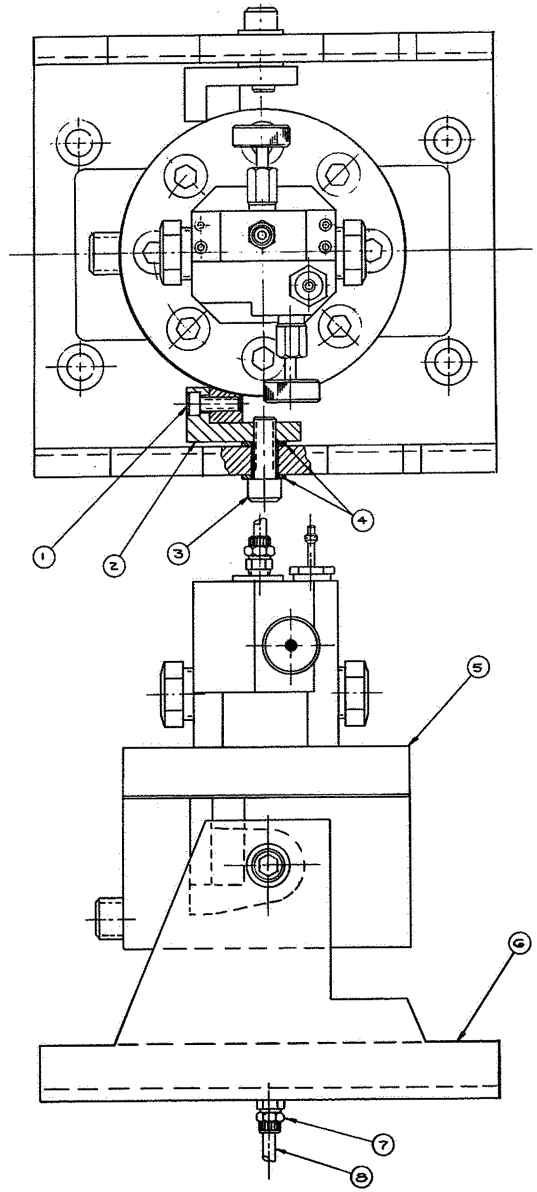

SECTION A-A
SECTION B-B
DETAIL-A
SCALE 2:1
DETAIL A
DRILL .546 DIA. THRU
C'BORE .781 DIA. x .52 DP
(8) HOLES EQUALLY SPACED
ON 3.75 B.C.
DRILL .089 DIA
TAP 4-40NC-2 x .31 DP
(4) HOLES
DRILL .120 DIA.
x .71 DEEP
THR'D 7/8-20UNEF-3B
THR'D 11/16-24NEF-3B
.43 DEEP
9/16-18UNF-2A
BRAZE
.120 DIA.
.360 DIA.
CHAM 45° x .05
.307 5/16-24NF-2B
UNDER CUT .06 x .03 DP
DRILL .120 DIA.
DRILL .187 DIA.
(2) PLACES
NOTES
1. BREAK SHARP EDGES & REMOVE BURRS .005-.010 UNLESS OTHERWISE SPECIFIED.
2. RADIUS TO BE .06-.08 UNLESS OTHERWISE SPECIFIED.
3. PAINT IN ACCORDANCE WITH MIL-F-14072 PRIME WITH ONE COAT OF ZINIC CHROMATE PRIMER PER MIL-P-6889
4. ALL SURFACES MARKED "X" SHALL BE FREE OF PAINT
REVISIONS
GULTON INDUSTRIES, INC.
METUCHEN, NEW JERSEY
CAVITY PLATE
90634 D 110367
SCALE 1:1
KM-4011
MATERIAL BRASS FED. SPEC. QQ-B-626 COMP 22 1/2 H (ALLOY 271)
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DSGN G. J. BALOG
KM4011 110364 110621
MODEL NEXT ASSY B/M
APPLICATION
QTY REQD

FIGURE 1



1. SHALL BE AS SUPPLIED BY IMPERIAL EASTMAN

ITEM NO.	QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL OR NOTE
8	A/R	COMM.	POLY-FLO TUBE 44P		1
7	1	COMM.	MALE CONNECTOR 266P		1
6	1	110354	CAVITY MOUNT WELDMENT ASSY.		
5	1	110364	ASSY. HIGH INTENSITY CALIB.		
4	4	110358	SPACER		
3	2	COMM.	SOC. HD. CAP SCR. 3/8-16 NC-2A		
2	2	110355	BRACKET		
1	4	COMM.	SOC. HD. CAP SCR. 1/4-28 NF-2A		

LIST OF MATERIAL OR PARTS LIST

MODEL	NEXT ASSY	B/M	NEXT ASSY	FINAL ASSY
KM4011		110621	1	1

APPLICATION — QTY REQD

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ± 1/64 DECIMALS XX ± .005 XXX ± .002 ANGLES ± 0°-30'

MATERIAL

PROTECTIVE FINISH

DO NOT SCALE DRAWING

SIGNATURES		DATE
DR	Vopat C.	2-17-65
DSGN		
CHKD		
ENGR	[signature]	2-18-65
APPD	[signature]	2-19-65

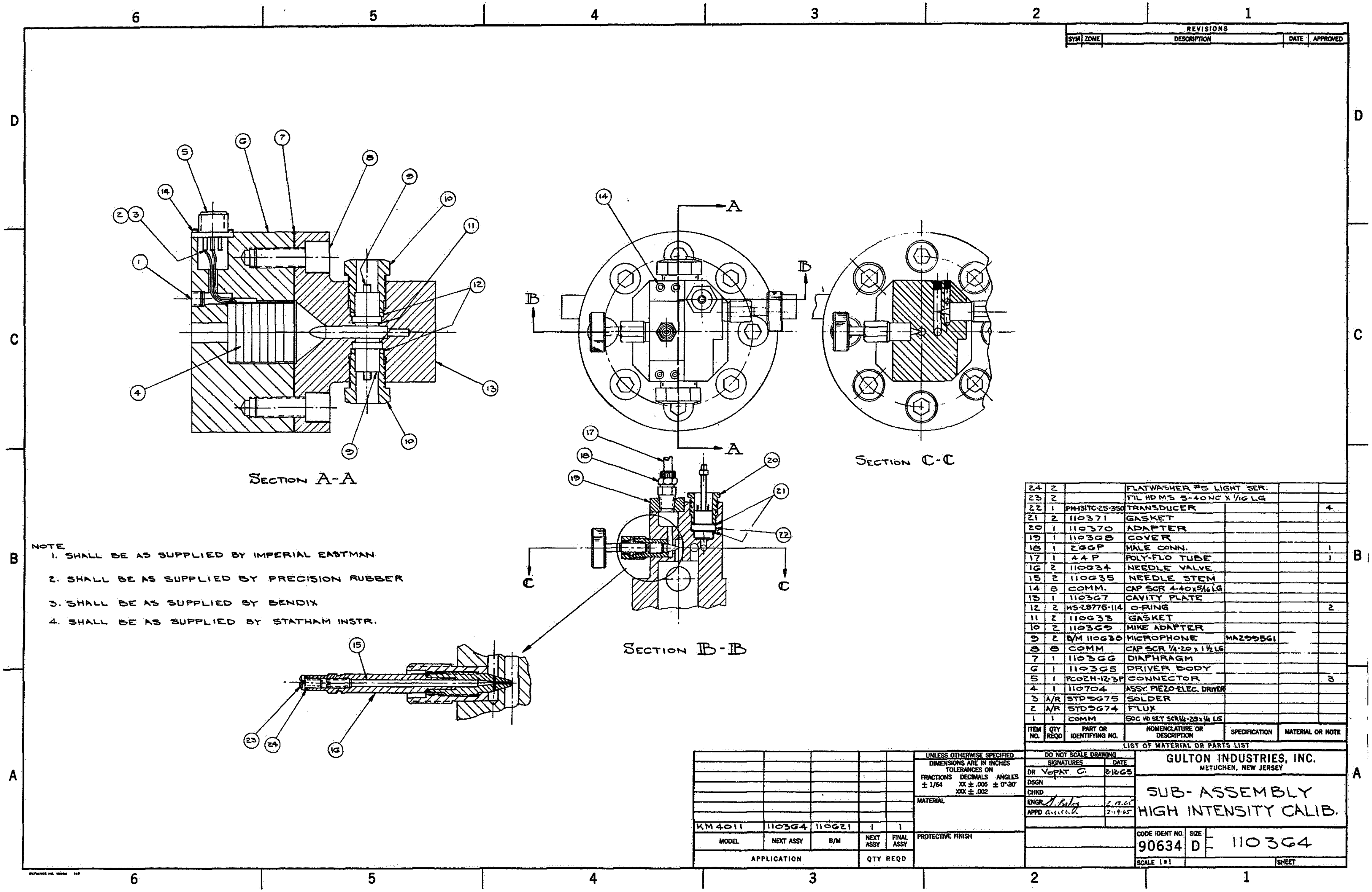
GULTON INDUSTRIES, INC.
METUCHEN, NEW JERSEY

ASSEMBLY
HIGH INTENSITY CALIB.

CODE IDENT NO. 90634 SIZE D 110749

SCALE 1=1 SHEET

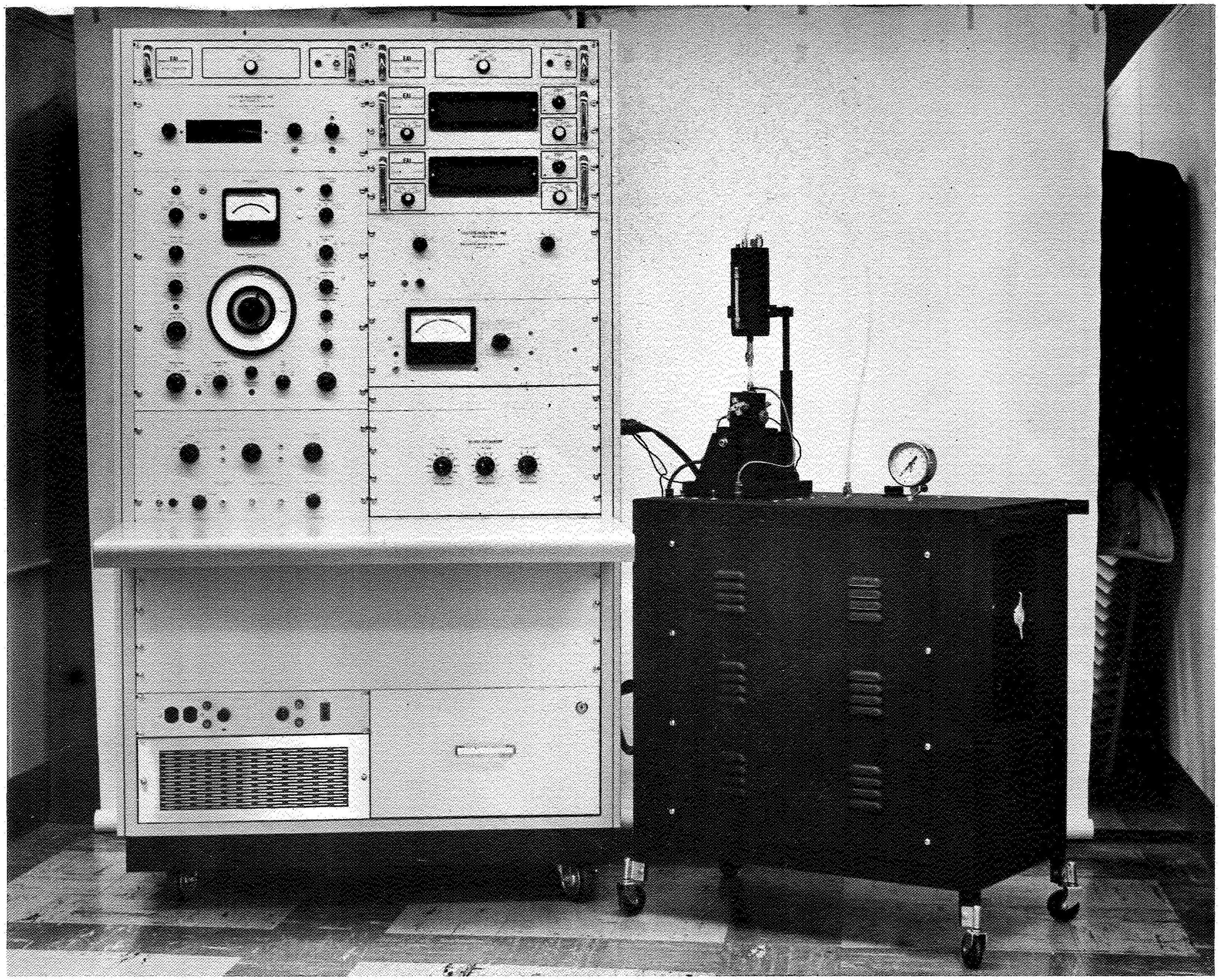
FIGURE 2



ITEM NO.	QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL OR NOTE
24	2		FLATWASHER #5 LIGHT SER.		
23	2		FIL HD MS 5-40NC X 1/16 LG		
22	1	PM-131TC-25-350	TRANSDUCER		4
21	2	110371	GASKET		
20	1	110370	ADAPTER		
19	1	110368	COVER		
18	1	266P	MALE CONN.		1
17	1	44P	POLY-FLO TUBE		1
16	2	110634	NEEDLE VALVE		
15	2	110635	NEEDLE STEM		
14	8	COMM.	CAP SCR 4-40x5/16 LG		
13	1	110367	CAVITY PLATE		
12	2	MS-28775-114	O-RING		2
11	2	110633	GASKET		
10	2	110369	MIKE ADAPTER		
9	2	B/M 110638	MICROPHONE	MA299561	
8	8	COMM	CAP SCR 1/4-20 x 1 1/2 LG		
7	1	110366	DIAPHRAGM		
6	1	110365	DRIVER BODY		
5	1	PC02H-12-3P	CONNECTOR		3
4	1	110704	ASSY. PIEZO-ELEC. DRIVER		
3	A/R	STD9675	SOLDER		
2	A/R	STD9674	FLUX		
1	1	COMM	SOC HD SET SCR 1/4-28 x 1/4 LG		

LIST OF MATERIAL OR PARTS LIST

FIGURE 3



GLENNITE® HIGH INTENSITY SOUND CALIBRATION SYSTEM
TYPE KM-4011

FIGURE 4

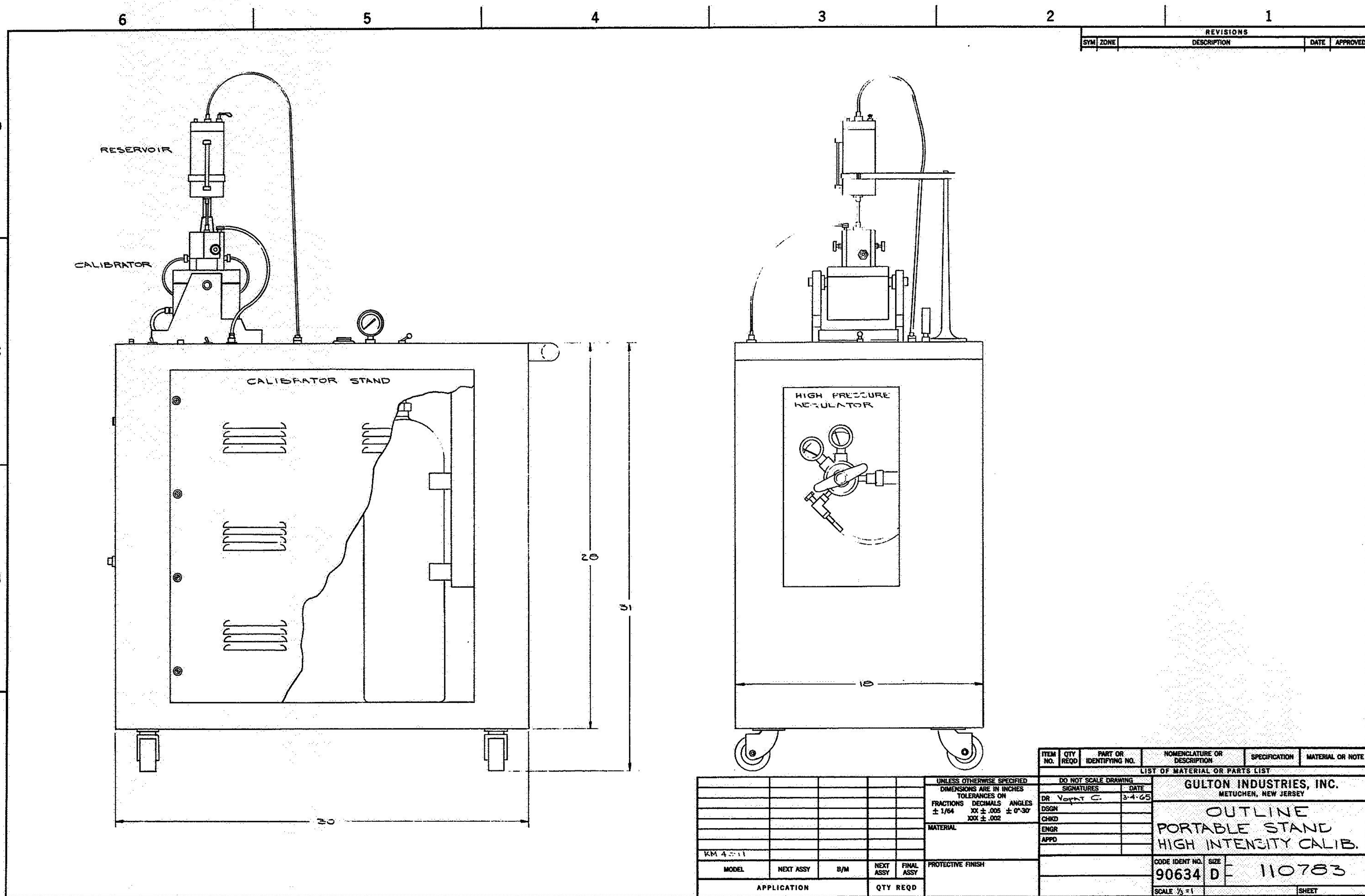
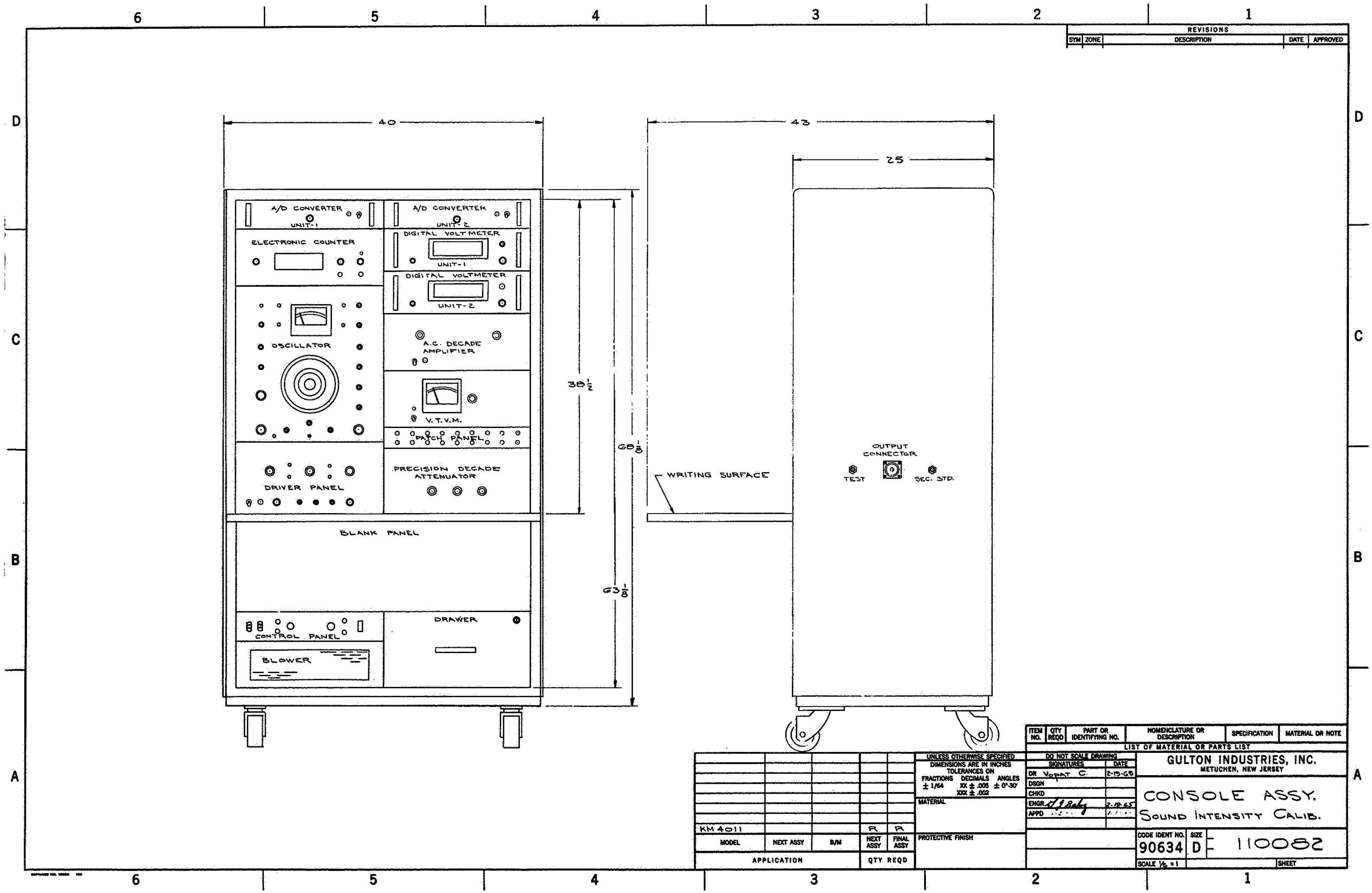

RESERVOIR
CALIBRATOR
CALIBRATOR STAND
HIGH PRESSURE REGULATOR
28
31
30
18
REVISIONS
SYM ZONE DESCRIPTION DATE APPROVED
ITEM NO. QTY REQD PART OR IDENTIFYING NO. NOMENCLATURE OR DESCRIPTION SPECIFICATION MATERIAL OR NOTE
LIST OF MATERIAL OR PARTS LIST
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES ± 1/64 XX ± .005 ± 0°-30' XXX ± .002
MATERIAL
PROTECTIVE FINISH
DO NOT SCALE DRAWING
SIGNATURES DATE
DR Voght C. 3-4-65
DSGN
CHKD
ENGR
APPD
GULTON INDUSTRIES, INC.
METUCHEN, NEW JERSEY
OUTLINE
PORTABLE STAND
HIGH INTENSITY CALIB.
CODE IDENT NO. 90634
SIZE D
110783
SCALE 1/3 = 1
SHEET
KM 4
MODEL NEXT ASSY B/M NEXT ASSY FINAL ASSY
APPLICATION QTY REQD

FIGURE 5



REVISIONS
SYM ZONE DESCRIPTION DATE APPROVED
40
43
25
A/D CONVERTER UNIT-1
A/D CONVERTER UNIT-2
ELECTRONIC COUNTER
DIGITAL VOLTMETER UNIT-1
DIGITAL VOLTMETER UNIT-2
OSCILLATOR
A.C. DECADE AMPLIFIER
V.T.V.M.
PATCH PANEL
DRIVER PANEL
PRECISION DECADE ATTENUATOR
BLANK PANEL
CONTROL PANEL
BLOWER
DRAWER
$38\frac{1}{2}$
$68\frac{1}{8}$
$63\frac{1}{8}$
WRITING SURFACE
OUTPUT CONNECTOR
TEST
SEC. STD.
ITEM NO. QTY REQD PART OR IDENTIFYING NO. NOMENCLATURE OR DESCRIPTION SPECIFICATION MATERIAL OR NOTE
LIST OF MATERIAL OR PARTS LIST
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES ± 1/64 XX ± .005 ± 0°30' XXX ± .002
MATERIAL
PROTECTIVE FINISH
DO NOT SCALE DRAWING
SIGNATURES DATE
DR Vopat C. 2-15-65
DSGN
CHKD
ENGR 2-19-65
APPD
GULTON INDUSTRIES, INC.
METUCHEN, NEW JERSEY
CONSOLE ASSY.
SOUND INTENSITY CALIB.
CODE IDENT NO. 90634
SIZE D
110082
SCALE 1/8 = 1
SHEET
KM 4011
R R
MODEL NEXT ASSY B/M NEXT ASSY FINAL ASSY
APPLICATION QTY REQD

FIGURE 6

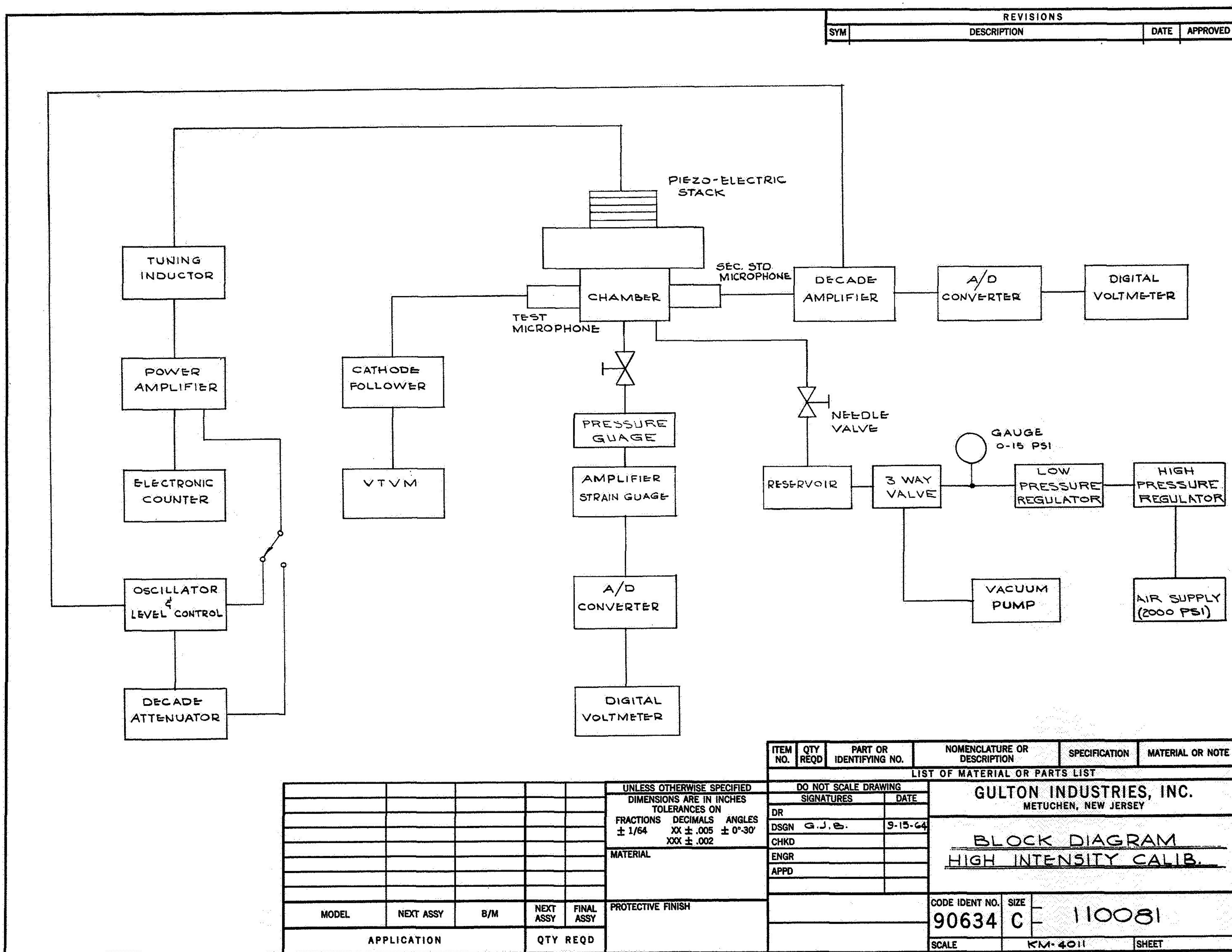

REVISIONS
SYM
DESCRIPTION
DATE
APPROVED
PIEZO-ELECTRIC STACK
TUNING INDUCTOR
CHAMBER
SEC. STD. MICROPHONE
DECADE AMPLIFIER
A/D CONVERTER
DIGITAL VOLTMETER
TEST MICROPHONE
POWER AMPLIFIER
CATHODE FOLLOWER
PRESSURE GUAGE
NEEDLE VALVE
GAUGE 0-15 PSI
ELECTRONIC COUNTER
VTVM
AMPLIFIER STRAIN GUAGE
RESERVOIR
3 WAY VALVE
LOW PRESSURE REGULATOR
HIGH PRESSURE REGULATOR
OSCILLATOR & LEVEL CONTROL
A/D CONVERTER
VACUUM PUMP
AIR SUPPLY (2000 PSI)
DECADE ATTENUATOR
DIGITAL VOLTMETER
ITEM NO.
QTY REQD
PART OR IDENTIFYING NO.
NOMENCLATURE OR DESCRIPTION
SPECIFICATION
MATERIAL OR NOTE
LIST OF MATERIAL OR PARTS LIST
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACTIONS ± 1/64
DECIMALS XX ± .005 XXX ± .002
ANGLES ± 0°-30'
MATERIAL
PROTECTIVE FINISH
DO NOT SCALE DRAWING
SIGNATURES
DATE
DR
DSGN G.J.B. 9-15-64
CHKD
ENGR
APPD
GULTON INDUSTRIES, INC.
METUCHEN, NEW JERSEY
BLOCK DIAGRAM
HIGH INTENSITY CALIB.
CODE IDENT NO. 90634
SIZE C
110081
SCALE
KM-4011
SHEET
MODEL
NEXT ASSY
B/M
NEXT ASSY
FINAL ASSY
APPLICATION
QTY REQD
DEFIANCE NO. 1000H 848

FIGURE 7

FREE FIELD OPEN CIRCUIT CALIBRATION
Microphone: Gulton Model MA299561*
Serial Number 101

Owner: Gulton Industries

Calibrated by J.O.
Date 1-15-65
Approved J.O.

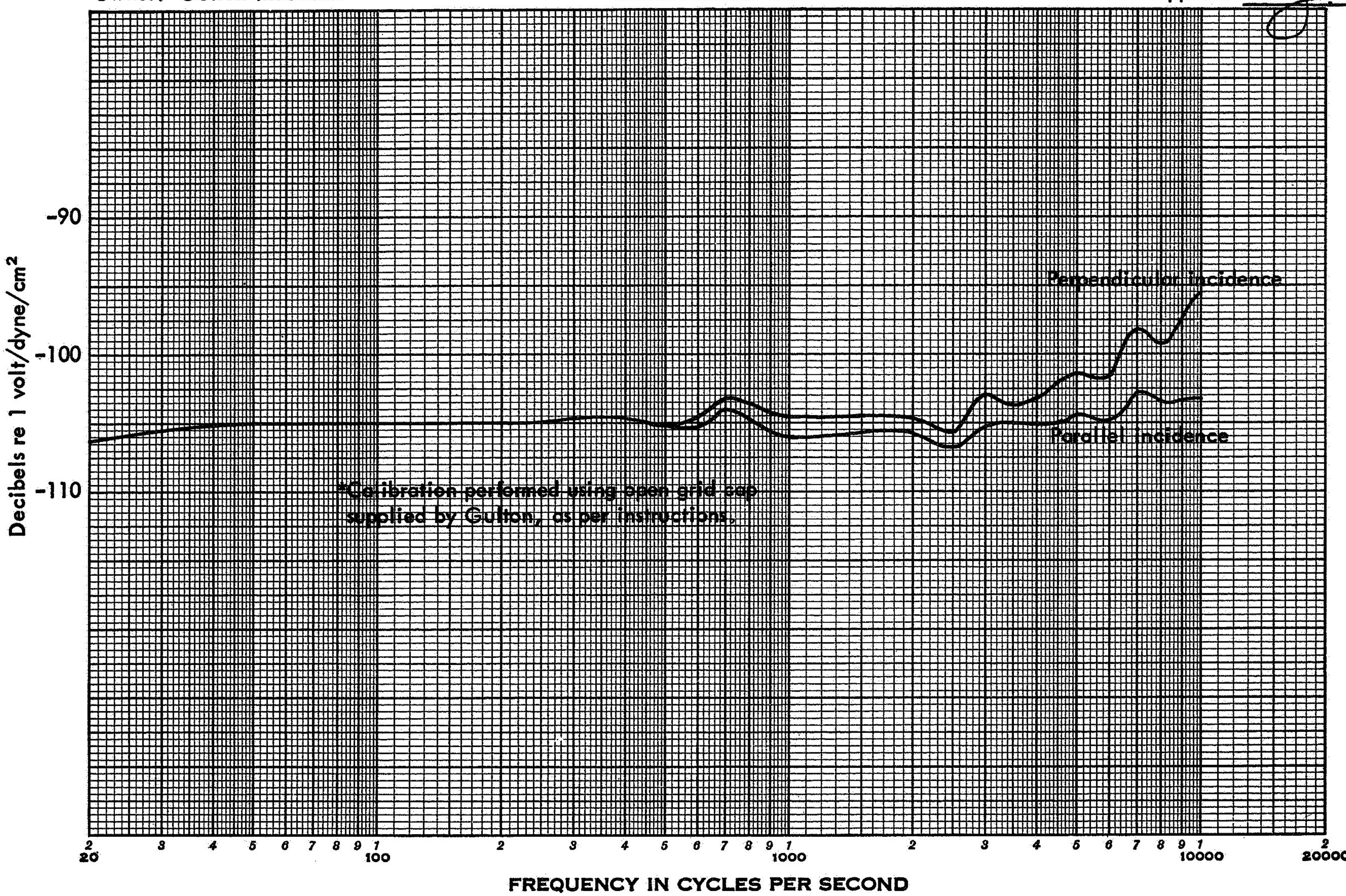


FIGURE 8

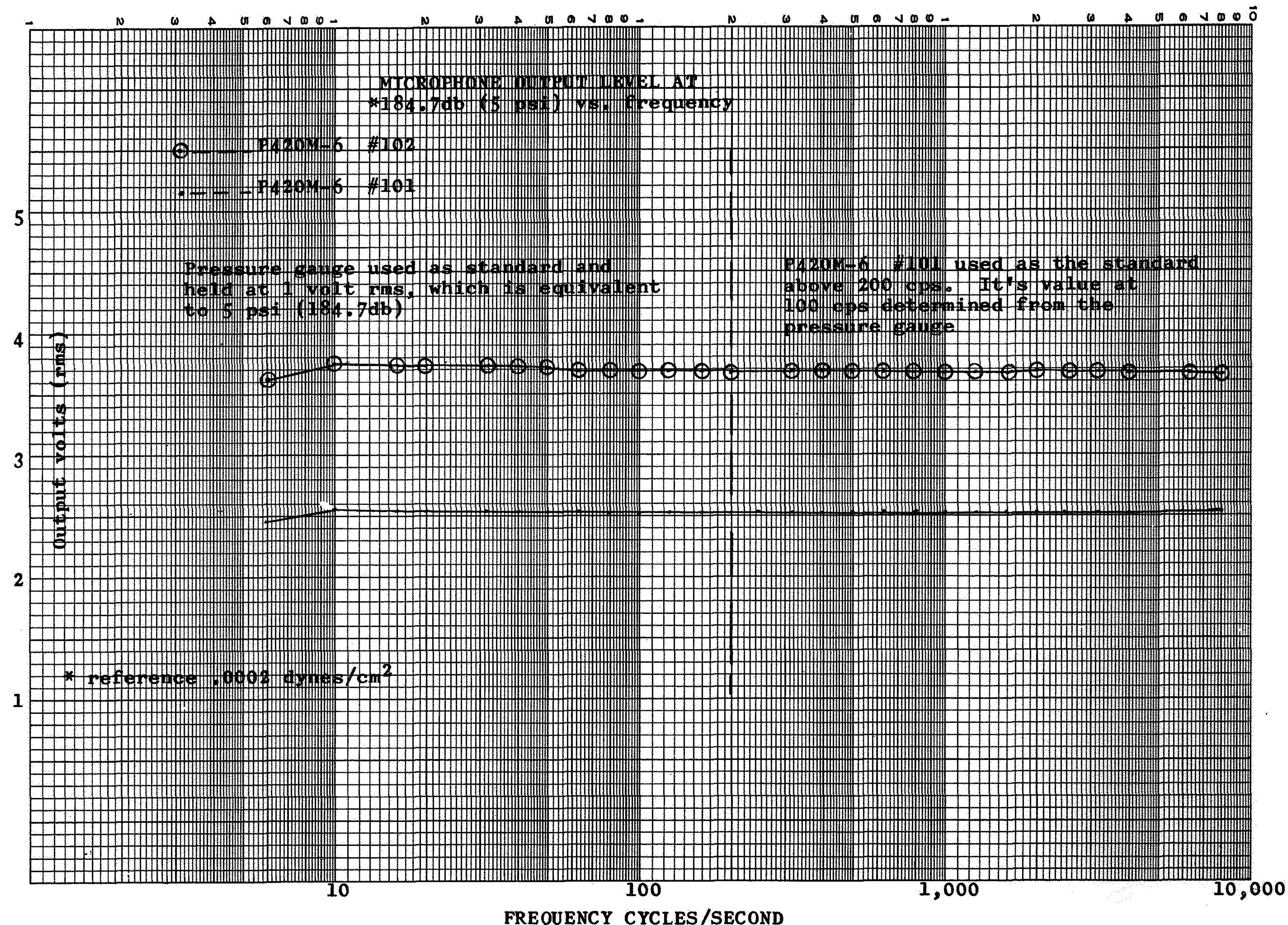

MICROPHONE OUTPUT LEVEL AT
*184.7db (5 psi) vs. frequency
P420M-6 #102
P420M-6 #101
Pressure gauge used as standard and held at 1 volt rms, which is equivalent to 5 psi (184.7db)
P420M-6 #101 used as the standard above 200 cps. It's value at 100 cps determined from the pressure gauge
* reference .0002 dynes/cm2
Output volts (rms)
5
4
3
2
1
10
100
1,000
10,000
FREQUENCY CYCLES/SECOND

FIGURE 9

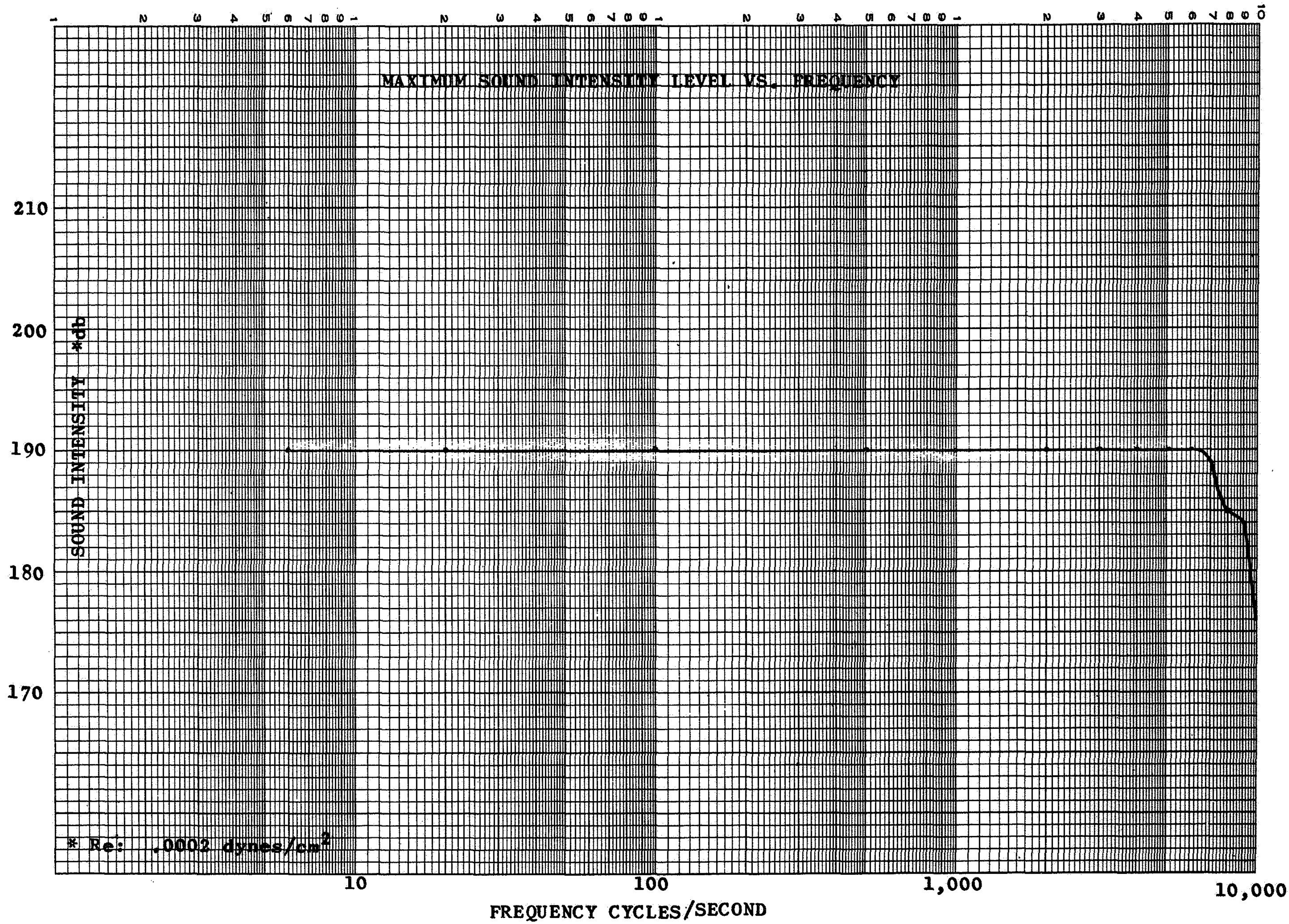

MAXIMUM SOUND INTENSITY LEVEL VS. FREQUENCY
SOUND INTENSITY *db
210
200
190
180
170
10
100
1,000
10,000
FREQUENCY CYCLES/SECOND
* Re: .0002 dynes/cm2

FIGURE 10